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# THE BIOLOGICAL WORK OF AMERICAN EXPERIMENT STATIONS.[1]

BY CLARENCE M. WEED.

AS was to be expected, nearly all of the published work of the biological departments of American experiment stations (and for the present purpose I mean, by these, the departments of zoology and botany, including entomology, ornithology, and mycology), up to the present time, has been of a purely practical nature, usually having an immediate application to agricultural procedure. This is perfectly right and exactly what has been needed. There has been, and is yet, a great demand for this sort of work, and it must be satisfied so far as possible if the enterprise is to continue to receive encouragement and support. The problems of spraying, of remedies for the great crop pests, whether insect or fungous in nature, of the effects of rotation and fertilization upon the increase of insects and fungi, and many similar subjects, furnish opportunities for a vast amount of useful work, which must on no account be neglected. But, nevertheless, is there not a tendency to confine ourselves too strictly to these purely practical problems, when very often a somewhat wider study would not only shed light upon the case in hand, but add much useful knowledge besides? Should not our work be organized and conducted on so broad and comprehensive a basis that our results will be cumulative, and in the years to come aid in the formulation of general biological laws?

We are so used to hearing about economic entomology, economic botany, and economic ornithology, that I fear even some of us have an idea that the main field of entomology, or botany, or ornithology, is not economic, but belongs to that department of pure science possessing, in the words recently quoted by Dr.

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[1] This paper, in substantially its present form, was prepared for the Entomological Section of the Association of American Agricultural Colleges and Experiment Stations at its recent Champaign meeting, but was not read on account of the limited time at the disposal of the section.

Mendenhall, "the inestimable value of being of no practical utility whatever." But surely this is an error. I believe that every addition to our knowledge of the biology, classification, or distribution of an animal or plant will sooner or later be found useful. The organisms about us are so intimately related to each other and to their environment that we cannot say to one or a few of them: "Thou art of practical account; thee alone will we study." For when we come to investigate even the smallest insect thoroughly, we find that it is simply a part of a vast and complex organism, and that it is vitally related to other creatures in a thousand ways. It is preyed upon by "the fowl of the air and the fish of the sea"; frogs are ever ready to lick it up with their viscid tongues, and toads are lying in wait to send it in search of the mystic jewel within their bodies; quadrupeds in great variety esteem it a delicate morsel, and other insects devour it bodily, or suck out its life-blood, or gnaw away its vitals; bacterial germs are ever ready to destroy it, and the spores of Cordyceps and Empusa are but waiting an opportunity to develop within its body; its alimentary canal may contain a rich and varied fauna and flora, revealed only by the microscope, and the plant upon which it feeds is subject to a thousand agencies that make for its weal or woe. In short, it is engaged in an intense struggle for existence, and an adequate knowledge of the insect itself necessarily involves a consideration of the forces engaged in the struggle.

In the same way, if we would learn the economic status of a bird, we must study its food, its habits, its enemies. To do this properly involves an acquaintance with a large portion of the flora and fauna where the bird occurs,—not a mere knowledge of species, but an acquaintance with their habits and histories. And an adequate knowledge of a plant involves a study of a vast number of organisms,—a study of the insects that attack its roots; those that burrow in its stems; that feed upon its leaves, within or without; that visit its blossoms; that mine its fruit; of those that find in its foliage or flowers concealment from prey or protection from enemies; of the birds that devour its fruit and scatter its seed; of the quadrupeds that browse upon its foliage or gnaw its bark; and of numerous other agencies to which it sustains vital relations.

In view of this intimate relation between the organisms with which we have to deal, it seems to me that one of the first needs of our work is the organization of biological surveys of our respective states; and to this point I invite your special attention.

In that masterly essay published just ten years ago this month, entitled "On Some Interactions of Organisms," Dr. S. A. Forbes stated that "the principal general problem of economical biology is that of the discovery of the laws of oscillation in plants and animals, and of the methods of nature for its prevention and control." This is as true to-day as it was then, and so also is this paragraph that immediately follows it:

"For all this, evidently, the first, indispensable requisite is a *thorough knowledge of the natural order,—an intelligently conducted natural history survey.* Without the general knowledge which such a survey would give us all our measures must be empirical, temporary, uncertain, and often dangerous."

At various times in the history of many of the United States provision has been made for more or less complete natural history surveys. As a rule they have been combined with geological surveys, but this has been by no means universal. In Illinois the work has very appropriately been given to the State Laboratory of Natural History, the first of the series of final reports—an elaborate monograph of Illinois birds by Robert Ridgway—having lately been issued. In Kansas such a survey has been undertaken by the scientific staff of Washburn College, and in other western states scientific associations are at work upon it.

It must be confessed that the results of these surveys on the whole are incomplete and unsatisfactory. In no state can there be found a series of volumes containing an adequate account of its flora and fauna. The reason is not far to seek. The provision made for their support has been meagre and insufficient; to one man has been given the work of ten, and he has often also been compelled to compass in a single season investigations requiring a decade for their proper completion. As a rule the work has also been of a transient nature, and very rarely has it rested on a fairly permanent basis. A knowledge of the flora and fauna of a state is not to be gained in a day nor a year, nor even, under ordinary circumstances, in a decade. It requires the coöperation of several specialists, with facilities for field and laboratory investigations, rooms for the storage of large numbers of duplicate specimens, a library of American and foreign natural history literature, extensive reference collections, means of producing illustrations, and opportunities for the publication of results,—in short, the methods and equipment of a permanent institution of investigation.

So far as I am aware, Illinois is the only state, unless perhaps we except New York, that has supplied these conditions in a fairly respectable manner. For fifteen years it has maintained a State Laboratory of Natural History, one of the main objects of which has been to make a systematic natural history survey of the state. The work of this laboratory, as published in its series of bulletins, has obtained the most gratifying recognition from the scientific world; and the initial volume of the final reports gives promise of a series of great value and importance. The director is now engaged upon the second volume concerning birds, treating of the food habits and economic relations of the various species, for the Illinois survey is not to be a mere catalogue of forms, but is to include the investigation and discussion of the relations of the organisms to each other and to agriculture.

It is scarcely probable that, for the present, at least, other states will follow to any great extent the example thus set by Illinois. Even there, where the work of Kennicott, Walsh, LeBaron, Riley, Ridgway, Thomas, French, and Forbes has given natural history a prominence and popularity enjoyed by no other western state, it has often been difficult to get the meagre appropriations furnished for the work. But it seems to me that the organization of an experiment station in each state furnishes an opportunity for the conducting of such surveys upon a permanent and well-established basis. Nearly all of them include departments of botany and entomology, with specialists in charge, and in many the college biological departments are closely connected. A knowledge of the flora and fauna of the states would furnish exactly the foundation needed for the prosecution of the distinctively economic work; and the two lines of investigation could very well be carried on together. To illustrate this point let me again quote from a recent report by Professor Forbes, in which the relations of the Illinois State Laboratory of Natural History to the Illinois Station are discussed. He says:

"The recent organization, at the university, of the State Agricultural Experiment Station has raised the question of the relations of the work thus instituted to that of the Natural History Laboratory and the State Entomologist's Office, with the effect to bring about an adjustment of the two at their points of contact in crytogamic botany and economic entomology. The purpose of the State Laboratory being essentially scientific and educational, its results are only incidentally economic; while the purposes of the Experiment Station are essentially economic, and its scientific work must naturally be regulated with close reference to practical results. In cryptogamic botany, for example, the Laboratory is engaged in a general survey of the state, intended to give us the species, the classification, and the life-history of all our flowerless plants, whether economically important or not, and the relations of these to agriculture will come in as a purely secondary matter; while in Experiment Station work, on the other hand, little attention will probably be paid to any species except those having economic relations. *All practical botanists are agreed, however, that the economic species and those of no economic importance are so intimately related in classification, habit, and life-history, that a full and exhaustive knowledge of the whole subject is very helpful, and often indispensable, for the solution of merely economical problems.* The more, in short, the State Laboratory is able to do in technical and biological botany, the easier and more fruitful will be the economic work of the botanical department of the Station. The former should, in fact, supply a broad and strong foundation on which the latter may build elaborately.

"As much of the work in the two directions requires substantially the same facilities, methods, skill, and knowledge, the two may be easily combined in a way to economize labor and expense and to increase results, the only requisite being a common scheme of subdivision and adjustment of proper subjects of research, and a proper arrangement with respect to assistance, separate and conjoint, in the two departments. Substantially the same may be said of the entomological work."

The Illinois station is fortunate, indeed, to have available the results of the long years of exhaustive work of the laboratory force, but for most of us there is no such reserve fund of knowledge upon which to draw, and if the foundation is obtained we must build it ourselves.

There are other advantages to accrue from such an undertaking besides those to be gained in the direct prosecution of the economic work. One of the greatest of these will be found in the stimulus given to natural history studies. A well-known botanist recently stated that nothing so stimulates the study of a group of plants as a good monograph. In the same way monographs or descriptive catalogues of the organisms of a locality or state are a great help to local naturalists; and there can be no doubt that the existence of volumes similar in plan to that of Ridgway's Illinois birds, treating of the mammals, birds, shells, insects, and plants, would greatly increase the number of students of natural history. We can all remember how eagerly, in our boyhood days, we attempted to get help from books in determining the species, as well as the habits and histories, of the organisms about us. A large proportion of farmers' boys are born naturalists, and it is only because they receive no encouragement and help that so many of them grow away from their early love. It is needless to say that by so increasing the number of nature students the stations would be doing a great service, not only to the agricultural community, but also to themselves,—to the former by adding to the enjoyment of rural life, to the intelligence of the farming community, to the mastery of the farmer's profession; and to the latter by increasing the number of trained observers, to whom experiments and observations may safely be trusted.

Of the methods to be employed in such surveys little need be said at this time. They will necessarily vary with the circumstances and the organizing skill of the individual in charge. But an indispensable requisite in all cases will be that a system of record and arrangement be adopted that is permanent, expansible, and easily applied, and by means of which the data obtained will be readily available at any time. Much aid also can nearly always be obtained by the judicious use of student assistants and local naturalists, both in making collections and working out results.

I am well aware that this idea will not meet with favor in the eyes of many critics of station work, especially those who are crying for a deluge of immediate practical results, and who often can see nothing "practical" in any result which does not carry with it as a passport the odor of the barnyard, the aroma of the onion bed, or the subtle flavor of insecticides like whale-oil soap. But criticisms from such sources should not prevent the undertaking of the work. The history of all the sciences related to agriculture shows that the investigations of greatest value have been those having to do with the discovery of general laws, and on the surface such investigations have often seemed of the most theoretical and impractical nature.